SUBSTITUTE SPECIFICATION

TITLE: READ-ONLY RECORD CARRIER WITH RECORDABLE AREA IN SUBCODE CHANNEL

INVENTOR(S):   PETRUS H.C. BENTVELSEN ET AL.

SERIAL NO.:   10/511,209

ATTY. DOCKET NO.:   PHNL 020307

READ-ONLY RECORD CARRIER WITH RECORDABLE AREA IN SUBCODE CHANNEL

BACKGROUND OF THE INVENTION

Field Of The Invention

[0001]   The invention relates to a method and an apparatus for providing a read-only record carrier on which user data can be

5   recorded at predetermined recordable positions of subcode frames of a subcode channel after mastering of said record carrier. The invention relates further to a method of and an apparatus for writing user data onto such a read-only record carrier, to a computer program for implementing said methods, and to a record

10   carrier mastered according to said method.

Description Of The Related Art

[0002]   It is often desired that even on a read-only record carrier, such as a CD-audio or CD-ROM, after mastering certain user

15   data can be stored on the record carrier. In particular, it is desired to generate a unique identifier of said record carrier by the distributor or sales point of said record carrier and/or to provide copy protection data on said record carrier mainly to prevent a user from making unauthorized copies of said record

20   carrier, or to enable replay devices to distinguish between an original and a copy of a record carrier.

SUMMARY OF THE INVENTION

[0003]   It is therefore an object of the present invention to provide a read-only record carrier on which user data can be recorded after mastering. In addition, a corresponding method of

5   writing user data to such a record carrier shall be provided.

[0004   Said object is achieved according to the present invention by a method comprising the steps of:

[0005]   setting the subcode symbols at said predetermined recordable positions to a first predetermined symbol value during

10   mastering,

[0006]   calculating, for each subcode frame, error detection data over certain subcode data of said subcode frame including said subcode symbols set to said first predetermined symbol value,

[0007]   storing said error detection data at auxiliary data

15   positions in said subcode frame, and

[0008]   setting error detection data positions in said subcode frame to a second predetermined symbol value,
said predetermined recordable positions of said subcode frames being provided for recording of user data to it during writing of

20   data, and said error detection data positions of said subcode frames being provided for recording correct error detection data, calculated after recording said user data to said predetermined recordable positions, to it.

[0009]   A method of writing user data to such a record carrier

25   comprises the steps of:

[0010]   recording user data to said predetermined recordable
positions of said subcode frames during writing of data, and

[0011]   recording correct error detection data, calculated after
recording said user data, to said error detection data positions of

5   said subcode frames.

[0012]   The present invention is based on the idea of providing a
possibility to modify certain symbols of the subcode channel even
after mastering the record carrier. Therefore, the symbols at
predetermined recordable positions of subcode frames and error

10   detection data positions are set to a predetermined value which can
be changed after mastering. However, in order to achieve that the
error detection data is always correct, both after mastering, i.e.,
before writing of said particular user data, and after writing said
user data, said error detection data are calculated after

15   mastering. While the normal cyclic redundancy check (CRC) data is
inverted and stored in the conventional CRC position, said data is
not inverted and is stored in the auxiliary data positions. Said
auxiliary data positions can but must not be recordable after
mastering, so that, in the latter case, the values at said

20   auxiliary data positions remain unchanged even after the later
writing the user data at the recordable positions.

[0013]   According to a preferred embodiment, said subcode channel
is the Q-channel as defined in the Red Book for CD audio, or as
defined in the Yellow Book for CD-ROM. The error detection data

25   thus preferably comprises cyclic redundancy check data which are

preferably calculated over a control field, an address field and a user data field.

[0014]   To enable the recording of user data even after mastering, the subcode bytes comprise subcode symbols of all subcode channels, i.e., for CD audio of subcode channels P, Q, R, S, T, U, V, W. Said subcode bytes are set to value 0x47 during mastering so that the Q-channel symbol has bit value 1. Said value 0x47 can be easily changed into value 0x07 even after mastering so that the Q-channel symbol has bit value 0 by writing a mark at a predetermined position so that the pattern 3T pit - 3T land - 3T pit is modified into the pattern 9T pit. Preferably, merging bits are chosen such that the polarity of EFM word corresponding with 0x47 (corresponding EFM word is 00100100100100) starts with a 'pit'.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]   The invention will now be explained more in detail with reference to the drawings, in which:

[0016]   Fig. 1 shows a block diagram of an encoder according to the present invention;

[0017]   Fig. 2 illustrates the frame structure of the subcode channels in CD audio;

[0018]   Fig. 3 illustrates the frame format of a Q-channel subcode frame;

[0019]   Figs. 4a-4d illustrate the method according to the present invention; and

[0020]   Figs. 5a-5e illustrate how user data can be recorded after mastering.

5

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021]   Fig. 1 shows a block diagram of an encoder according to the present invention as used during mastering of a disc. Content, such as audio, video or software data, is inputted into a main

10   channel data unit 1 for processing, in particular encoding, said content into main channel data. Other information, in particular general data, such as table of content (TOC) data and track time information, is inputted into a subcode data unit 2 for processing, in particular encoding, said data into subcode data. An AUX

15   calculator 3, which can be enabled or disabled, is provided, according to the present invention, in the processing path of said subcode data which can be used to provide the possibility of writing user data at certain predetermined positions of a subcode channel even after mastering. Auxiliary (AUX) data positions are

20   therefore provided in subcode frames of at least one subcode channel to which certain data will be recorded as will be explained below. Error detection data, in particular, cyclic redundancy check (CRC) data, are calculated for the subcode data to be stored in subcode frames by a CRC calculator 4. An EFM (Eight-to-Fourteen

25   Modulation) modulator 5 converts the data of the main channel and

the sub-channels into channel bits of a data stream which is finally recorded on the disc by a laser beam recorder 6. The general layout and function of an encoder for recording data onto an optical disc is well known and shall therefore not be described

5   further. For particular details, reference is made to standards for optical recording, such as the Red Book for CD audio or the Yellow Book for CD-ROM.

[0022]   Fig. 2 shows the well-known structure of EFM frames and subcode frames as used in CD audio. One frame F of channel bits

10   comprises 98 EFM frames each comprising an EFM synchronization pattern, a subcode byte, user data bytes and error detection parities. The 98 subcode bytes together form a subcode data block S comprising 8 subcode frames of 8 different subcode channels, i.e., the P, Q, R, S, T, U, V, W subcode channels. Each subcode channel

15   consists of 98 subcode bits that are built by 2 synchronization bits and 96 data bits.

[0023]   Fig. 3 illustrates the data content of the subcode frame of the Q-channel in CD technology. In the shown non-limiting embodiment, the Q-subcode frame contains, in the following order,

20   two synchronization pattern bits 202 which contain bits from special symbols S0 and S1 (2 bits), a control field 204 (CONTROL, 4 bits), an address field 206 (ADR, 4 bits), a track number field 208 (TNO, 8 bits), a track number index field 210 (X, 8 bits), a track time minutes field 212 (MIN, 8 bits), a track time seconds field

25   214 (SEC, 8 bits), a track time frame field 216 (FRAME, 8 bits), a

field of zero bits 218 (ZERO, 8 bits), an absolute time minutes

field 220 (A MIN, 8 bits), an absolute time seconds field 222 (A

SEC, 8 bits), an absolute time frame field 224 (A FRAME, 8 bits),

and a cyclic redundancy check field 226 (CRC, 16 bits).

5   **[0024]**   With reference to Figs. 4a-4d, a particular embodiment of

the present invention shall now be explained in more detail. Fig.

4a shows a simple layout of a subcode frame of the Q-channel.

According to said layout, the subcode frame comprises a

synchronization field 10, a control field 11, an address field 12,

10   a UDI (Unique Disc Identifier) index field 13 and a UDI field 14.

The UDI field 14 is provided for storing a unique disc identifier

uniquely identifying a particular disc. Such an UDI is often used

in copy protection systems. In particular embodiments of replay

devices, said UDI is required to enable playback or copying of

15   content stored on a disc. However, if it is detected that the disc

that is to be played back or copied is not an original disc but an

illegal copy, then the output of the UDI can be suppressed so that

playback or copying is not possible.

[0025]   According to the present invention, during mastering, the

20   UDI field 14 is set to 0xFF FF FF FF FF FF, i.e., all subcode bits

of the UDI field 14 are set to bit value 1. Error detection data

CRC are thereafter calculated over the control field 11, the

address field 12, the UDI index field 13 and the UDI field 14.

However, the calculated auxiliary CRC data 15 are not inverted and

25   are stored in an auxiliary data field 16 instead of the normal CRC

field, as shown in Fig. 4b. During calculation of said auxiliary CRC data, it is taken into account that the initial value is zero and the result is not inverted so that the CRC data stored in CRC data field 17 of the complete subcode frame shown in Fig. 4c has

5 value 0xFF FF, i.e., all bits of the CRC data field 17 have bit value 1. Thus, the CRC stored in the CRC data field 17 is correct for the data stored in the remaining fields 11, 12, 13, 14 and 16 of the subcode frame after mastering.

[0026] According to the present invention, at least the UDI

10 field 14 and the CRC data field 17 are recordable after mastering, i.e., user data can be stored in the UDI field 14 and new corrected CRC data, taking into account a new payload in the UDI field 14, can be calculated and stored in the CRC data field 17. A user, e.g., the content owner or a sales person, can assign a particular

15 unique identifier UDI to the disc and store it in the UDI field 14 as shown in Fig. 4d. Thereafter the CRC data are again calculated over the control field 11, the address field 12, the UDI index field 13, the UDI field 14 and the AUX field 16, and the correct CRC data are stored in the CRC data field 17. Thus, the CRC data

20 are correct before and after writing the user data into the UDI field 14. It is thus possible to use a stamper-unique identifier and an optional disc-unique identifier at the same time.

[0027] Figs. 5a-5e illustrate how the writing of user bits after mastering is enabled. Fig. 5a shows the EFM synchronization pattern

25 followed by two possibilities of three merging bits for polarity

control, followed by a subcode byte comprising a subcode bit for each subcode channel, followed by a fixed merging bit pattern. To enable the writing of user bits into the subcode frame of the Q-channel, the subcode byte is set to byte value 0x47 which channel

5   word corresponds to data word 01000111 (=71 in decimal format). This means that the subcode bit for the Q-channel is set to bit value 1. Fig. 5a shows the pattern of pits and lands for said bit pattern.

[0028]   To change the bit value of the subcode bit for the Q-

10   channel, the subcode byte value has to be changed from byte value 0x47 to 0x07, the bit pattern of which is shown at the bottom. Said subcode byte value 0x07 corresponds to a data word 00000111 (=7 in decimal format), i.e., the subcode bit of the Q-channel has bit value 0. This can be achieved by writing a 3T mark indicated by the

15   arrow in Fig. 5b, resulting in a pit and land pattern as shown in Fig. 5c. The sequence of 3T pit-3T land-3T pit shown in Fig. 5b is thus modified into the pattern 9T pit shown in Fig. 5c.

[0029]   Fig. 5d shows the pit and land pattern before the recording of user data, starting with the opposite polarity of the

20   pits and lands and using a second merging bit pattern between the synchronization pattern and the subcode byte. Fig. 5e shows the pit and land pattern after changing the subcode byte from value 0x47 into 0x07.

[0030]   It should be noted that the present invention is not

25   limited to the above-described embodiments. It can be applied to

other record carriers as well, and it can be modified such that user data can also be stored in other subcode channels after mastering. Further, the number and the positions of recordable data bits within a subcode frame can be varied compared to the above-

5   described embodiment. It could be provided that not only the UDI field 14 and the CRC data field 17 as shown in Figs. 4a-4d can be modified after mastering, but that also the control field 11, the address field 12, the UDI-index field 13 and/or the auxiliary data field 16 can be modified after mastering.

10